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When, however, a spermatozoan enters the egg through the micropyle this micropyle should, by analogy with the observed conditions in various other insect eggs, become closed, thus preventing poly-fertilization. If this is so then a double mating should after all result in but a single fertilization, and these fertilizations should be roughly divided between the two male types.

Thus in double mating a female Bagdad White with Bagdad White and Istrian Yellow males, the fertilizations should be, roughly, equally divided between pure race Bagdad White and crossed Bagdad and Istrian Yellow. And in accordance with these fertilizations half of the  $F_1$  generations thus produced should be white cocooning and half yellow cocooning (yellow being dominant in crossings with white). If an Istrian Yellow female is mated with both Istrian Yellow and Bagdad White males  $F_1$  generations should always be composed of all yellow cocooning individuals. Or if in these double matings all of the fertilizations are effected by spermatozoa of one of the males only then the  $F_1$  lots should be either all white cocooning or all yellow cocooning.  $F_2$  generations from these lots should follow the Mendelian order and break when the  $F_1$  individuals are hybrids and not break when they are pure race progeny.

But the data given above do not reveal the expected behavior. They evidence a considerable perturbation in the order of inheritance. The  $F_1$  lots are not always all white or all yellow, or equally divided between white and yellow as they seemingly should be. Or if such all white or all yellow  $F_1$  lots are produced, they often throw both yellows and whites in  $F_2$  lots when only yellows or only whites should have appeared. Or if they do produce all white or all yellow  $F_2$  lots intermating in these lots may produce both yellows and whites in  $F_3$  lots. In a word the inheritance behavior is not that which it should be in animals usually following a Mendelian order, if the only influence at work on the egg is the nuclear content of a single pure race spermatozoan.

What, then, is causing this perturbation in the order of inheritance? Do the eggs in double-mated females receive more than one spermatozoan and are these spermatozoa often the representatives of both the races used in the double mating? Or can the egg be in any way influenced by the mere presence in the spermatheca of spermatozoa representing both of a pair of allelomorphic heritable characters? Can fluids carrying the spermatozoa have any influence during fertilization? Can the spermatozoa of one type influence those of the other type during their enforced companionship for several hours or days in the female spermatheca?

All that we think we know of the mechanism of fertilization and heredity makes us answer "No" to each of these questions. Then why should the order of inheritance in the silkworm moth be different in the generations after these double matings from the order in the generations following a single mating?

VERNON L. KELLOGG

STANFORD UNIVERSITY, CAL.

### SOCIETIES AND ACADEMIES

#### THE NATIONAL ACADEMY OF SCIENCES

At the stated meeting of the academy on April 18-20, the following papers were read:

"On the Motions of the Brighter Helium Stars," W. W. Campbell.

"Report of Progress in Spectrographic Determinations of Stellar Motions," W. W. Campbell.

"The Evolution of Periodic Solutions of the Problem of Three Bodies," F. R. Moulton.

"Mechanical Quadratures," G. F. Becker.

"Corollaries of the Theory of Isostasy," W. M. Davis.

"Experimental Investigation on Reflection of Light at Certain Metal-liquid Surfaces," Lynde P. Wheeler (introduced by C. H. Hastings).

"On the Origin of the Peaks of Maximum Pressure in the Midst of the Permanent Tropical Oceanic Highs," W. J. Humphreys (introduced by Cleveland Abbe).

"A Further Study of Columbic and Tantallie Oxides," E. F. Smith.

"The Outlook of Petrology," J. P. Iddings.

"The Orogenic Development of the Northern Sierra Nevada," Waldemar Lindgren.

"Biological Conclusions drawn from the Evolution of the Titanotheres," H. F. Osborn.

"A New Reptile from the Newark Beds," W. B. Scott.

"Restorations and Ontogeny of the Eurypterids," J. M. Clarke.

"A Geological Reconnaissance in the Rocky Mountains of British Columbia," Chas. D. Walcott.

"Comparative Study of the Early Stages of Vertebrates," C. S. Minot.

"Infantile Paralysis and its Mode of Transmission," Simon Flexner (read by C. S. Minot).

"Cell-size and Nuclear-size," E. G. Conklin.

"The Cause of Death of the Unfertilized Egg and the Cause of the Life-saving Action of Fertilization," Jacques Loeb.

"Studies of the Pulmonary Circulation," Horatio Wood, Jr. (introduced by H. C. Wood).

"An American Lepidostrobos," J. M. Coulter.

"Aristotle's History of Animals," Theo. Gill.

"Notes on New England Mollusca," E. S. Morse.

"Changes in Bodily Form of Descendants of Immigrants," Franz Boas.

"Classification of Shoshonean Tribes," C. Hart Merriam.

"The Outside and the Inside of the Yosemite Indian," C. Hart Merriam.

"Biographical Memoir of W. H. C. Bartlett," E. S. Holden.

"Biographical Memoir of C. B. Comstock," H. L. Abbot.

"Biographical Memoir of S. W. Johnson," T. B. Osborne.

"Biographical Memoir of Benjamin Silliman, 1816-1885," A. W. Wright.

"Biographical Memoir of James H. Trumbull," A. W. Wright.

"Biographical Memoir of C. A. White," Wm. H. Dall.

"Biographical Memoir of Joseph Leidy," Henry Fairfield Osborn.

#### THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and fifty-third regular meeting of the society was held at the University of Chicago on Friday and Saturday, April 28-29, 1911, the occasion being especially marked by the presidential address of Professor Maxime Bôcher on "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations." This was the first regular meeting of the society,

except the summer meetings, that has been held elsewhere than in New York city. The attendance exceeded all previous records, reaching a total of 115, including 88 members. Fifty-three papers were presented at the four sessions.

The president of the society, Dean H. B. Fine, of Princeton University, occupied the chair, being relieved by Professor G. A. Miller and Vice-president G. A. Bliss. The council announced the election of the following persons to membership in the society: Professor H. Bateman, Bryn Mawr College; Mr. Samuel Beatty, University of Toronto; Professor J. H. Griffith, University of Michigan; Mr. E. J. Moulton, Harvard University; Mr. George Spitzer, Agricultural Experiment Station, Purdue University; Professor C. J. West, Ohio State University. Eleven applications for membership in the society were received.

Professor L. E. Dickson was reelected to the editorial board of the *Transactions* for a term of three years. A committee was appointed to arrange for the summer meeting and colloquium to be held at the University of Wisconsin in 1913.

Friday evening was devoted to the usual dinner, at which 73 members were present.

The following papers were read at this meeting:

Daniel Buchanan: "A class of periodic solutions of the problem of three bodies, two of equal mass, the third moving in a straight line."

H. E. Buchanan: "An expansion of elliptic functions with applications."

D. R. Curtiss: "Relations between the Gramian, the Wronskian, and a third determinant connected with the problem of linear dependence."

L. L. Dines: "On the representation of resultants of polynomials in one variable."

L. L. Dines: "On the solution of three equations for three variables in terms of others."

W. D. MacMillan: "A reduction of a system of power series to an equivalent system of polynomials."

W. D. MacMillan: "A method for finding the solutions of a set of analytic functions in the neighborhood of a branch point."

R. L. Moore: "On the transformation of double integrals."

Maxime Bôcher (presidential address): "Charles Sturm's published and unpublished work on differential and algebraic equations."

L. P. Eisenhart: "A fundamental parametric representation of space curves."

A. E. Young: "On certain orthogonal systems of lines and the problem of determining surfaces referred to them."

Arnold Emch: "The differential equation of curves of normal stresses in a plane field."

A. B. Frizell: "A set of postulates for well-ordered types."

C. J. Keyser: "Sensuous representation of paths that lead from the inside to the outside of

an ordinary sphere in point four-space without penetrating the surface of the sphere."

Edward Kasner: "The subdivision of curvilinear angles."

R. D. Carmichael: "The general theory of linear  $q$ -difference equations."

R. D. Carmichael: "Note on multiply perfect numbers."

G. A. Miller: "Isomorphisms of a group whose order is a power of a prime."

R. G. D. Richardson: "Theorems of oscillation for two self-adjoint linear differential equations of the second order with two parameters (second paper)."

J. B. Shaw: "Quaternion functions of three parameters."

J. E. Rowe: "The combinants of two binary cubics and their geometrical interpretation on the rational cubic curve."

U. G. Mitchell: "Geometry and collineation groups of the finite projective plane  $PG(2, 2^2)$ ."

G. E. Wahlin: "The decomposition of rational primes into ideal prime factors in the field  $k(\sqrt[m]{m})$ ."

L. C. Karpinski: "An Italian Algebra of the fifteenth century."

C. H. Sisam: "On hyperconical connexes in a space of  $r$  dimensions."

R. E. Root: "Iterated limits of functions on an abstract range."

E. B. Van Vleck: "On the generalization of a theorem of Poincaré."

E. B. Van Vleck: "On the classification of collineations."

A. R. Schweitzer: "On the philosophy of Grassmann's extensive algebra."

A. R. Schweitzer: "On the 'working hypothesis' in the logic of mathematics."

W. B. Ford: "A set of sufficient conditions that a function may have an asymptotic representation in a given region."

W. J. Montgomery: "The classification of twisted curves of the fifth order."

William Marshall: "On Hill's differential equation in the theory of perturbations."

H. Bateman: "The fundamental equations of the theory of electrons and the infinitesimal transformation of an electromagnetic field into itself."

N. J. Lennes: "Curves and surfaces in analysis situs."

N. J. Lennes: "Extension and application of a theorem of Ascoli."

L. I. Neikirk: "Substitution groups of an infinite degree and their related functions."

James Maclay: "Parabolic curves."

J. A. Nyberg: "Projective differential geometry of rational cubic curves."

E. B. Stouffer: "Invariants of linear differential equations with applications to ruled surfaces in five-dimensional space."

W. D. MacMillan: "A general existence theorem for periodic solutions of differential equations of a certain type."

A. R. Crathorne: "The catenary with variable end points."

F. R. Moulton: "Periodic orbits of superior planets."

F. R. Moulton: "On the curves defined by certain differential equations."

F. H. Safford: "An identical transformation of the elliptic element in the Weierstrass form."

W. H. Roever: "Southerly deviation of falling bodies (third paper)."

C. N. Moore: "Convergence factors in double series."

L. E. Dickson: "On the negative discriminants for which there is a single class of positive primitive binary quadratic forms."

L. E. Dickson: "On Fermat's 'descente infinie.'"

L. E. Dickson: "On perfect numbers and Bernoullian numbers."

O. E. Glenn: "On expressing a quantic in terms of assigned powers of a given quantic."

G. R. Clements: "Implicit functions defined in the neighborhood of a point where the Jacobian determinant is zero."

R. W. Marriott: "Determination of the groups of isomorphisms of the groups of order  $p^4$ ."

The summer meeting of the society will be held at Vassar College on Tuesday and Wednesday, September 12-13.

F. N. COLE,

Secretary

#### THE AMERICAN PHILOSOPHICAL SOCIETY

At the stated meeting of the society on April 7, Rear Admiral G. W. Melville (U. S. Navy, retired) read a paper on "A Century of Steam Navigation."

The author said: In looking back over the history of the human race we are struck with the fact that from time to time some genius brings to light, or develops a principle which forever after is a guide in our thinking. Such was Lord Bacon's exposition of inductive logic, which has been the basis of all scientific advancement.

Basing his argument on the above theory, the admiral followed the growth of steam navigation from the time of the inventions of James Watt, down to the time of Fulton's first commercial steamer *Clermont*, down to the time of the *Lusitania* and *Mauretania* of to-day.

He spoke of the varied improvements from that time up to the present time, including the many improvements, not only in ships and ship building from the wooden hulls to the present steel hulls, but the engines and boilers through their various stages of improvements, commencing with a low steam pressure of 10 pounds to the square inch up to the present time of about 300 pounds pressure per square inch.

He traced through the various steps the great evolution of steam ships from those of about 500 tons to those of 40,000 tons. Of necessity in a short lecture of but 40 or 45 minutes, a very

rapid tracing of the growth of steam navigation and marine engineering had to be quite limited. Nevertheless, the lecture seemed to be of great interest to his audience. And the fact of the growth of steam ships from the paddle wheels used to a large extent in the forties of the last century, through the propeller systems, and finally of the great advances made through the steam turbine, which is only an improvement of Hero's steam turbine of 2,000 years ago.

He mentioned the famous steamer *Great Eastern*, which was a wonder in her day, which is nearly a half century ago. She was simply about fifty years in advance of her time, for although a great engineering success, she was not a commercial success, which is the real measure in these days of what is considered a success in commercial life.

He laid great stress on the improved material with which the engineer could work to-day, without which it would be impossible to build the great vessels of 30,000 tons displacement, and 70,000 horsepower.

Another fact which he pointed out, and which is worth noting, was that high speeds properly belong to big ships, because experiments had shown that for a higher speed the resistance of a large ship per ton of displacement was very much less than that of a small one.

He dwelt upon the different types of battle-ships, from the *Dreadnought* type down to the small torpedo boat and torpedo-boat destroyer. Stating that in naval construction it was necessary to have the various classes of ships to fill their particular positions in the battle fleet, the same as the different arms of the service in the army, such as artillery, cavalry, infantry, etc.

After the lecture illustrations were made of the lecture proper, by means of a series of illuminated lantern slides.

#### THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 694th meeting was held on April 22, 1911, Vice-president Fischer in the chair. The following paper was read:

*The Scientific Aspects of the President's Inquiry into Economy and Efficiency*: DR. F. A. CLEVELAND, chairman, Committee on Economy and Efficiency.

The work that the committee had been asked to do was mentioned, and which, briefly stated, is that it was to make such concrete recommendations to the president as would enable him to act with greater economy and efficiency in the management of the business affairs of the government.

At the beginning there was little of scientific information of how the large business concerns of the government are organized or what the government is doing. The committee felt a grave responsibility. It assumed in the start that for progress and commendable results it was necessary to focus the attention of all in the service upon the subject of administration. This required a working hypothesis or common plan of cooperative effort or coordination. As the whole of this inquiry looks to something constructive, it first had to be decided what sort of information is needed by the man who is responsible for the conduct of the government's business.

The first work was to find out how the government is organized and what it is doing. The president asked each head of department to co-operate with the White House, and under their supervision the inquiries have been conducted. Diagrams and charts were exhibited showing the departmental organizations in their different divisions and branches and their activities, and how they are connected up and coordinated; these being based upon the reports and outlines of organization prepared by the several departments.

In describing the organization of the government's work, the speaker remarked in passing that one is really amazed when he knows what wonderful organizations some of the government offices are.

Reports were also secured describing the legal powers of the various departments and divisions of the government service throughout the country in order to ascertain the authority for the various activities pursued, and in these matters also the committee had appealed for their information to the men in the service who had been living the parts; to those directly concerned.

The committee assumed that the cost of the government's activities should be known, and that all should know that the administration of the government's affairs is economical. To ascertain this it is necessary to know, (1) that a thing is bought, (2) what is bought and (3) is it suitable for the purpose for which it is bought. Also in studying economy the relation of cost to results must be known.

The analysis of the costs of the government's activities in terms of administration, operation and maintenance were discussed, and how the analysis was applied in arriving at standards of judgment of costs in relation to results.

R. L. FARIS,  
Secretary